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Japan Report

SCIENCE AND TECHNOLOGY

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JAPAN REPORT

SCIENCE AND TECHNOLOGY

CONTENTS

BIOTECHNOLOGY

Specified Bioindustry Technology Research Promotion Organization Outlined
(Keiji Watanabe; NORINSUI SANSHO KOHO, Jul 86) 1

ENERGY

Technological Developments of Nuclear Power Discussed
(DENKI TO GASU, Jun 86) 12

METALLURGICAL INDUSTRY

Nonferrous Metal Industry's High-Tech Strategy Discussed
(KOGYO ZAIRYO, Aug 86) 16

NEW MATERIALS

Mitsui Toatsu Promoting Development of New Polymer Products
(TOSHI KEIZAI, Jun 86) 21

Ceramic Coating Technology Discussed
(J. Sasaki; NIKKO MATERIALS, May 86) 25

NUCLEAR DEVELOPMENT

MITI's 21st Century Nuclear Energy Vision Announced
(GENSHIRYOKU SANGYO SHIMBUN, 24 Jul 86) 32

SCIENCE AND TECHNOLOGY POLICY

Changes in System for Selling Government-Owned Patents Discussed
(JITA JAPAN INDUSTRIAL TECHNOLOGY ASSOCIATION, Aug 86) 50

SPECIFIED BIOINDUSTRY TECHNOLOGY RESEARCH PROMOTION ORGANIZATION OUTLINED

Tokyo NORINSUI SANSHO KOHO in Japanese Jul 86 pp 10-14

[Article by Keiji Watanabe of the Office on Special Measures for Technical Development, Promotion Division of the Agriculture, Forestry and Fisheries Technology Council staff]

[Text] Introduction: Technological development is not only a very important element in economic growth, it is also something which facilitates steady progress toward qualitative enhancement of the nation's standard of living; it is the source of power opening up an abundant future.

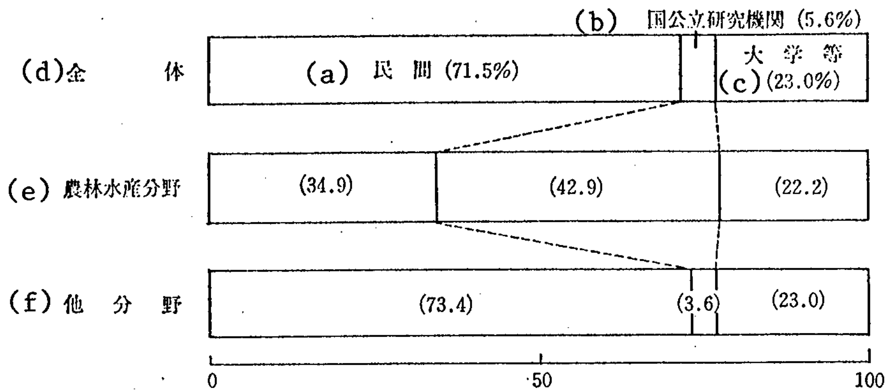
In recent years, especially, there have been startling technological innovations in such fields as biotechnology, electronics and new materials. The influence of technological development on the Japanese economy and standard of living has grown greater and greater. The Ministry of Agriculture, Forestry and Fisheries [MAFF] has a long-range desire to promote the agriculture, forestry and fisheries industries, and to assure an abundant and healthy diet. Strengthening our technological development policy is therefore a very important task, ranking with such things structural adjustment policy. It has thus come to be thought that creation of a new framework, to include introduction of private-sector vitality, is an urgent task.

The recently promulgated "Specified Biological Industry Technological Research Promotion Organization Law" is founded on that fundamental understanding, and has added a new scheme to MAFF's existing implementation setup. This paper describes the background prior to formulation of this law, and will introduce the work to be carried out by the Specified Biological Industry Technological Research Promotion Organization.

1. Anticipated biological industry technology: The course of technological innovation in recent years has been startling; the developments in advanced technologies such as biotechnology have been particularly outstanding. In the fields of agriculture, forestry and fisheries industries, there are plans to raise the technological level by developing or introducing these new technologies; the anticipated new developments include development of epochal new varieties and new products, and rapid improvement of productivity.

Because of the nature of the technology (work with living substances, the effects of natural conditions, the broad geographical scope, the riskiness and great lead time), private activity in the fields of agriculture, forestry and fisheries industrial technology in Japan has been slight compared with that in other fields. Thus the role played by experimental research at public institutions at the national and prefectural level has been great (see figure 1).

[Figure 1] Breakdown of research spending by organizations (FY 1983)



(a) Private
(b) National and public research institutions
(c) Universities etc
(d) Overall
(e) Agriculture, forestry and fisheries industries
(f) Other fields

Source: "Science & Technology Research Survey Report" Administrative Management Agency Statistical Bureau

Note 1) Private sector includes companies, private research organs and chartered organizations

Note 2) In the agriculture, forestry and fisheries fields, companies include those in the food products industry. The national and public research institution and university activities are those in the agricultural sciences.

Nevertheless, surrounded by the technological innovations mentioned above, there is rapidly increasing private sector interest in agriculture, forestry and fisheries-related technology as a field in which great progress can be expected (see table).

[Table] Fields of planned technology development by private enterprises

	(a)業種 / 分野	総(b)計 実数(g)	総(b)計 増加率(h)(%)	(c)種苗等 実数(g)	(c)種苗等 増加率(h)(%)	(d)食品・飲料 実数(g)	(d)食品・飲料 増加率(h)(%)	化(e)学 実数(g)	化(e)学 増加率(h)(%)	(f)医薬品 実数(g)	(f)医薬品 増加率(h)(%)
(i)	1 農林水産業	88	151.7	26	123.8	24	133.3	14	200.0	2	200.0
(j)	(1) うち品種改良	67	152.3	26	152.9	18	138.5	13	185.7	0	
(k)	(2) うち種苗増殖	59	178.8	22	122.2	14	155.6	9	180.0	2	200.0
(l)	2 食品・飲料	83	127.7	1	—	45	145.2	15	107.1	7	100.0
(m)	3 肥料・飼料	18	138.5	0	*	9	150.0	3	150.0	0	
(n)	4 農薬	25	125.0	0	*	6	150.0	15	115.4	4	133.3
(o)	5 動物用医薬品	32	188.2	0	*	10	166.7	7	233.3	11	137.5
(p)	6 一般医薬品	86	110.3	0	*	29	120.8	22	100.0	20	111.1
(q)	7 その他の化学品	62	147.6	1	—	16	177.8	25	125.0	5	125.0
(r)	8 排水処理等水質浄化	37	119.4	0	*	15	150.0	2	100.0	1	—
(s)	9 バイオセンサー等	34	200.0	0	*	12	240.0	5	250.0	1	100.0
(t)	10 その他	13	100.0	0	*	2	100.0	1	100.0	0	*
(u)	実施予定総会社数 (実回答数)	200	111.7	26	123.8	72	116.1	29	103.6	31	110.7

(a) Industry
(b) Total
(c) Seeds and seedlings, etc
(d) Foods and beverages
(e) Chemicals
(f) Medicines
(g) Raw number
(h) Rate of increase
(i) 1 Agriculture, forestry and fisheries industries
(j) (1) Improvement of stock
(k) (2) Propagation of stock
(l) 2 Foods and beverages
(m) 3 Fertilizers and feeds
(n) 4 Agriculture chemicals
(o) 5 Veterinary medicines
(p) 6 General medicines
(q) 7 Other chemicals
(r) 8 Water purification, including waste treatment
(s) 9 Biosensors, etc
(t) 10 Other
(u) Total number of companies with such plans (raw number of responses)

Note 1) The raw number is the sum of the number of companies planning to implement technological development making new use of biotechnology in the field specified and number of companies presently doing so.

Note 2) The rate of increase is the number of companies planning technological development in proportion to the number presently implementing such development.

Note 3) Study by the Office on Special Measures for Technical Development, Promotion Division, Agriculture, Forestry and Fisheries Technology Council staff

In the U.S. and Europe, both government and private sectors have actively taken up technological development in this field.

Considering these circumstances, Japan should of course strengthen experimental research in national and public institutions, but at the same time it should devise means to facilitate active participation in technological development in this field by the private sector. In order to promote administration of Japan's agriculture, forestry and fisheries industries and to contribute to improvement of the national standard of living, it is necessary for Japan as a whole to raise the level of technology in this field.

From that perspective, it was judged appropriate, as a system to encourage private technological development, to use a special law to set up a corporate entity as a liaison institution for comprehensive support of private research which encourages liaison between national experimental research institutions and the private sector, in addition to providing "risk money" for experimental research which the private sector could not accomplish alone under the existing system because the risk was too great, even though the public benefits and policy urgency were also great.

2. Functions and succession of the Institute of Agricultural Machinery: With the background described above, a study was made within MAFF.

What was conceived first was an "Agriculture, Forestry and Fisheries Industries New Technology Development Promotion Center" (tentative name). It was to be the central organization for supplying risk money and strengthening liaison between governmental and private sectors, in order to encourage experimental research by the private sector in the agriculture, forestry and fisheries field. It was to be a special approval corporation, established at private initiative and operated on the basis of private thinking.

This conception underwent two major revisions in the process of compiling the government's draft budget between the summer of 1985 and the end of that year.

One of these was that because of the "scrap and build" policy of no net increase in the number of special approval corporations and chartered corporations, it was decided to handle this through a reorganization of the Institute of Agricultural Machinery, a chartered corporation.

The Institute of Agricultural Machinery, was established in 1962 under the Agricultural Machinery Promotion Law. Its tasks include experimental research on improvement of agricultural implements and formal inspection of agricultural implements. Needless to say, this institute has played a great role in the advancement of Japanese agriculture. Since there will be no

change in the importance of these tasks under future agricultural policy, work on them will continue; although in form the institute will be disbanded with the formation of the new corporation, all its authority and responsibilities will be passed to the corporation, and the work of promoting agricultural mechanization will be carried on in parallel with new tasks.

The second major revision was that the scope of private research promotion by the new corporation was not limited to the industries within the jurisdiction of MAFF; it was broadened to include all industries dealing with organisms and their products. That is the reason for using the term "biological" in the name of the new corporation.

As background for these decisions, the previous fiscal year had seen the creation of the Basic Technology Research Promotion Center-- a corporation under the jurisdiction of MITI and MPT to promote private research on technology for the mining and manufacturing industries, the telecommunications industry and the broadcast industry-- using a similar system. From the perspective of promoting technological development in as unified a way as possible, while clarifying the relationship with that center, it was decided that it would be most appropriate to focus on the character of technology related to biology, and have an "open system" corporation not under the control of a single ministry or agency. It was also decided that the manufacture of tobacco products and alcoholic beverages, which are of course biological industries, would be within the scope of the new corporation when it was established (1986), and that jurisdiction over the corporation would be shared by MAFF and the Ministry of Finance [MOF]. Thus it was arranged that in the 1986 draft budget, the Industrial Investment Special Account (one of the fiscal loan and investment funds) would contain a 2.5 billion yen capital contribution and a 1.3 billion yen loan-- a total of 3.8 billion yen-- for the "Specified Biological Industry Technological Research Promotion Organization."

Legislation to establish the new organization was submitted to the 104th Ordinary Diet Session the following year, on 14 February 1986, as budget related legislation. Following careful deliberation in the Agriculture, Forestry and Fishery Committees of the upper and lower houses in April and May, the bill was passed on 14 May.

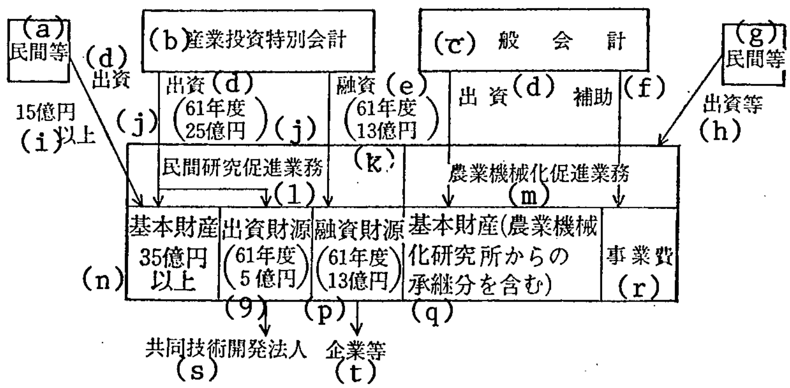
3. Duties of the new corporation:

(1) "The Specified Biological Industry Technological Research Promotion Organization:" This organization is a special approval corporation established at private initiative with both governmental and private capital participation on the basis of "The Specified Biological Industry Technological Research Promotion Organization Law."

The duties of this organization include (1) encouragement of experimental research concerning specified biological industry technologies carried out in the private sector (the private research encouragement duty) and (2) experimental research for encouragement of farm mechanization presently carried out by the Agricultureal Machinery Institute under the Agricultural Machinery Promotion Law (the farm mechanization encouragement duty).

The flow of funds for the organizations two duties is as shown in figure 2.

[Figure 2] Funding arrangements of the Specified Biological Industry Technological Research Promotion Organization



- (a) Private etc
- (b) Special Account for Industrial Investment
- (c) General Account
- (d) Capital contribution
- (e) Loan
- (f) Subsidy
- (g) Private etc
- (h) Capital contribution etc
- (i) At least 1.5 billion yen
- (j) (2.5 billion yen in 1986)
- (k) (1.3 billion yen in 1986)
- (l) Private research encouragement duty
- (m) Farm mechanization encouragement duty
- (n) Fundamental assets at least 3.5 billion yen
- (o) Capital investment resources (500 million yen in 1986)
- (p) Loan resources (1.3 billion yen in 1986)
- (q) Fundamental assets (including portion passed on from Agricultural Machinery Institute)
- (r) Administrative expenses
- (s) Joint Technology Development Corporation
- (t) Companies etc

(2) Testing and research covered by private research encouragement duty of this organization:

A. Specified Biological Industry Technological Research: This is experimental research in connection with technology used by those industries relying on organisms or products of their functions which are specified as fields in which encouragement of higher technology is necessary (currently the agriculture, forestry and fisheries industries and the manufacture of food products, tobacco and alcoholic beverages. (With regard to development, the covered technology is limited to that requiring experimental research closely connected with the functions of living organisms.)

Thus the covered experimental research is not limited to biotechnology, but can cover a broad range. For example, it covers technological development research for improving and enhancing food processing, livestock raising, and control of cultivation of crops through application of new materials or mechatronics.

Incidentally, the experimental research supported by this organization includes that from the the basic stage through the development stage, but not that in the commercialization stage, where there is no technological risk.

B. Implementation of experimental research: The "private" entities supported by this organization are those other than government, government-related or local public bodies. Aside from private enterprises in the form of companies, they can be agricultural, forestry or fisheries industrial groups like agricultural cooperatives, or public utility corporations established under civil law. Industrial sector, mode of establishment and size of capital holdings will not be an issue, as long as the entity carries out experimental research on specified biological industrial technology.

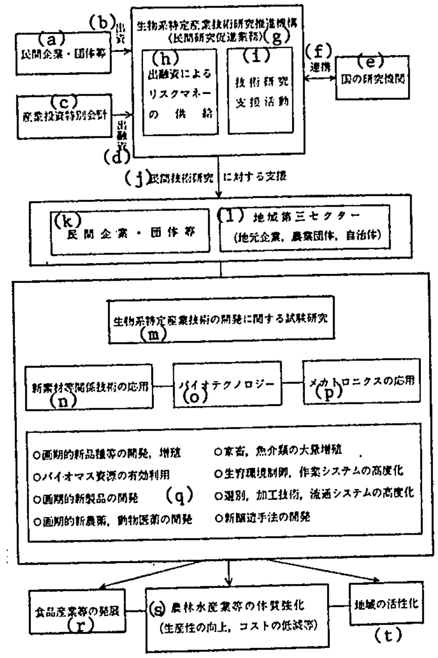
However, the entities in which the organization will invest are limited to companies which pay dividends on the basis of capital contributions.

C. Selection of projects covered: Projects covered will be decided from among amplications solicited or made after the establishment of the organization, following comprehensive investigation of individual necessity, urgency, technical feasibility and appropriateness.

(3) Major duties of the organization:

A. The following duties will be carried out in order to encourage experimental research in the private sector on specified biological industrial technology (see figure 3).

[Figure 3] Arrangement of duties of encouraging private research



(a) Private enterprises, groups etc
(b) Capital participation
(c) Industrial Investment Special Account
(d) Capital participation and loans
(e) National research institutions
(f) Liason
(g) Specified Biological Industry Technological Research Promotion Organization (duty of encouraging private research)
(h) Provide risk money through capital participation and loans
(i) Technological research support activities
(j) Support to private technological research
(k) Private interprises and groups
(l) Regional third sector (local enterprises, agricultural groups, local government bodies)
(m) Experimental research in connection with development of specified biological industry technologies
(n) Application of technology related to new materials etc
(o) Biotechnology
(p) Application of mechatronics
(q) -- Development and propagation of epochal new varieties etc
-- Mass propagation of livestock or marine species
-- Effective use of biomass resources
-- Control of habitat conditions, upgrading of operations system
-- Development of epochal new products
-- Upgrading of selection, processing technology and distribution systems

-- Development of epochal new pesticides and veterinary medicines
-- Development of new brewing methods

(r) Development of food products industry
(s) Strengthening of agricultural, forestry and fishery industries etc (increased productivity, reduced costs etc)
(t) Activation of regional forces

(a) Loans: Conditionally interest-free loans will be given to enterprises and groups doing experimental research, primarily in the applications research stage. This will reduce the risks and burdens which accompany research and development.

Loan conditions:

Grace period: Until completion of experimental research (up to 5 years in principle.

Repayment period: Up to 15 years in principle (including grace period).

Interest etc: Conditionally interest-free (if the experimental research in question is successful, payment of fixed interest will be requested at a rate corresponding to the degree of success).

Method of payment: Equal, semiannual principal payments.

(b) Capital participation: Capital participation will be made in joint technology development corporations (as long as they take the form of companies which pay dividends in accordance with capital participation) which conduct experimental research on specified biological industry technology (including advanced projects with a strong element of technology development) established jointly by two or more enterprises or an enterprise and an agricultural, forestry or fisheries industry group or a local public group.

This capital participation is expected to take the form of stock purchases.

Incidentally, both loans and investment can be done for successive experimental research periods for individual projects. Moreover, the expenses covered by loans and investment are expected to include expenses directly required for experimental research, such as site and facilities costs, personnel costs, and operating costs (but excluding land acquisition and preparation costs and, in the case of loans, administrative building acquisition).

(c) Facilitation of joint research: Intermediary services will be provided for experimental research to be conducted jointly by enterprises and government experimental research institutions (presently institutions subordinate to MAFF and MOF). In such cases, the organization will assist the private sector to be able to carry out effective joint research, in accordance with the needs of the private sector, in the following ways: (i) introduction to the government's joint research system; (ii) provision of information on joint research needs of government experimental research institutions (topics of joint research, conditions for acceptance etc); (iii) guidance on proposal

of plan for joint research with the government; and (iv) procedures for implementation of joint research with the government.

(d) Facilitation of provision of genetic resources: Intermediary services will be provided for provision of plant or other genetic resources collected and preserved in the "Agricultural, Forestry and Fisheries Gene Bank. In such cases, the organization will respond appropriately to the needs of the private sector in the following ways: (i) introduction to the government's system for distribution of genetic resources; (ii) provision of information on genetic resources which can be distributed (species, variety names, characteristics etc); (iii) guidance on selection of genetic resources in accordance with the needs of the private sector; (iv) procedures to apply to the government for distribution; and (5) other.

In addition to the above, the organization will implement the following to help encourage experimental research in the private sector: (i) recruitment of first-line researchers from abroad; (ii) collection, coordination and provision of expert data and research results from government experimental research institutions; (iii) survey of research and development trends in Japan and abroad; and (iv) commissioning of experimental research by persons outside the government.

B. With regard to the duty of promoting farm mechanization, the following will be carried out on the basis of the Agricultural Machinery Promotion Law: (i) Experimental research-- experimental research and surveys on improvement of farm tools, and diffusion of the results; and (ii) formal inspections etc-- formal inspection and appraisal of farm tools.

4. Active participation desired in private sector: The "Specified Biological Industry Technological Research Promotion Organization Law" was promulgated and put into effect on 10 June. The new organization is to be established this fall, following the meeting of sponsors, recruitment of capital and approval by key ministers. Studies and preparations for that time are being carried out at present.

This system is one of using government investment funds (the Industrial Investment Special Account) and having a corporation established jointly by the private and government sectors promote private sector experimental research dealing with industrial technology related to biology. Consequently, private capital will be solicited to build up the fundamental assets of the organization, and private initiative will be reflected in its establishment and its operation.

Considering the purposes and duties of this organization, it will involve a very broad range of enterprises and groups in the private sector. Whether or not they make direct use of this organization, a broad range of people in the agricultural, forestry and fishery industries and the populace in general will benefit from the reults of technology development.

In order for this organization to achieve its stated goals, it will be very important to obtain the understanding and support-- and also the active participation and cooperation-- of the broad range of agricultural, forestry

and fisheries industries, industrial organizations and related enterprises which have long taken an open-minded view of waiting for developments in Japan's agricultural, forestry and fisheries industries.

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TECHNOLOGICAL DEVELOPMENTS OF NUCLEAR POWER DISCUSSED

Tokyo DENKI TO GASU in Japanese Jun 86 pp 29-30

[Article: "Establishment and Present Status of ANERI Discussed by Kouhei Tomita, Vice-Chief Director of ANERI"]

[Text] I. What Is ANERI?

(1) The formal name of ANERI is the Advanced Nuclear Equipment Research Institute.

(2) A general inaugural meeting of ANERI as a voluntary foundation was held on 17 September 1985. It was attended by 19 foundations, such as the Ishikawajima-Harima Heavy Industries Co., Ltd. (IHI), as promoters. In addition, ANERI obtained approval as a technical research association based on the "Mining Industrial Technical Research Association Law" from the Ministry of International Trade and Industry on 7 October 1985, and started an enterprise on 14 October 1985.

(3) It appears that light water reactor (LWR) nuclear power stations will account for most of the electric power supply in Japan at least until the beginning of the 21st century. New materials--such as metallics, fine ceramics, and macromolecular materials--will be used in the facilities and equipment of LWR nuclear power stations. Finally, these LWR nuclear power stations will be maintenance- and inspection-free. In order to be viable, LWR's must have high efficiency, a long life span, and a high degree of economic efficiency in generating electric power. That is, the main purpose for the establishment of this technical research association is based on the concept, "Increase the technical level of LWR's."

II. ANERI Service System

(1) The address of the research institute offices is as follows: Terayama Pacific Building, 23-11, Toranomon 1-chome, Minato-ku, Tokyo 105.

(2) The internal office organization consists of a chief director, a vice-chief director, a representative director, a secretary general, a general affairs department (general affairs section), and a technical department (No 1 and No 2 technical sections). As of the end of March 1986, the number

of full-time directors and staff totaled 10. Also, a board of directors, a board of advisers, a steering committee, and a technical committee are included in ANERI to ensure its smooth operation.

(3) With regard to the research and development system, six subcommittees (as of the end of March 1986)--metallics, ceramics, macromolecular, dynamic equipment parts, static equipment parts, and investigation--and a managerial meeting for arranging these subcommittees had been set up under the technical committee.

(4) The funds (operating expenses) necessary for carrying out research and development work are subscribed from the electric power development special accounts-electric power diversification estimate (tests for confirming improved LWR technology, etc.). Some Y128 million and Y1.36 billion are appropriated for the fund in fiscal 1985 and fiscal 1986, respectively. According to the general inaugural meeting data, Y2.2 billion will be appropriated to the fund at the peak, and a total of about Y12 billion will be appropriated for it during the period from fiscal 1985-1993.

After a research and development theme is determined, including all new materials and equipment parts, these operating expenses will be entrusted to 30 of ANERI's copartners. Eight and 56 themes will be determined for fiscal 1985 and 1986, respectively. Also, in addition to the operating expenses, Y108 million and Y160 million will be appropriated for ANERI's working expenses and independent tests and research expenses, with consideration given to the dues obtained from these copartners in fiscal 1985 and the fiscal years subsequent to fiscal 1985, respectively.

(5) The 30 copartners are as follows: IHI, Kawasaki Steel Corporation, the Metallic Material Research and Development Center, the Industrial Development Research Institute, the Macromolecular Material Center, Kobe Steel, Showa Denko K.K., Nippon Steel Corporation, Sumitomo Metal Industries, Sumitomo Metal Mining Co., Sumitomo Electric Industries, Sekisui Chemical Co., Daido Steel Co., Denki Kagaku Kogyo K.K., the Electric Power Industry Central Research Institute, Toshiba Corporation, Nisshin Steel Co., NGK Insulators, Nippon Mining Co., Nippon Kokan K.K., the Japan Steel Works, NGK Spark Plug Co., Hitachi Chemical Co., Hitachi Metals, Hitachi, the Fine Ceramics Center, Bridgestone Tire Co., the Furukawa Electric Co., Mitsubishi Metal Corporation, and Mitsubishi Heavy Industries.

III. Enforcement Plan and Present Status of Research and Testing

(1) Test and Research Items and the Enforcement Plan

(a) The physical properties, processing methods, costs, etc., of materials that can be used in the equipment parts of LWR's will be studied in detail. These materials must sufficiently withstand the environmental conditions of LWR's. The economic efficiency of the system will be also studied in detail. When necessary, these materials will be additionally tested for physical property values. (These studies and tests will be conducted during the period from fiscal 1985-1989.)

(b) New materials will be tested to determine whether or not they can withstand the environment peculiar to LWR's, and equipment parts will be tested to determine whether or not their reliability can be further enhanced. The results obtained from these tests will be fed back to the improvement and development of materials, and will be used as supporting data for conducting confirmation tests of equipment parts. (These tests and work will be carried out during the period from fiscal 1986-1991.)

(c) New materials--such as metallics, fine ceramics, macromolecular materials, etc.--will be improved and developed, and parts will be manufactured on an experimental basis with consideration given to workability and material designs suitable for the needs and specifications of LWR equipment parts. (The improvement, development, and trial manufacturing work will be carried out during the period from fiscal 1986-1991.)

(d) New materials will be used in equipment parts with high development needs with a view to enhancing the quality of these equipment parts. The equipment parts and certification test facilities will be designed and manufactured, and the equipment parts will be subjected to certification tests. (This work will be carried out during the period from fiscal 1988-1993.)

(e) The adaptability of new materials to actual equipment parts will be evaluated with comprehensive consideration given to the results obtained from items a-d. (This evaluation will be carried out around fiscal 1993.)

(2) State of Activities of Each Subcommittee

The material subcommittees deliberate on the investigation and study of material seeds data, and on the abstraction and study of basic data on adaptable materials. The equipment parts subcommittees deliberate on the investigation and study of the needs of equipment, on the study of data on these equipment at the needs and seeds sides, on the philosophy of evaluating the adaptability of equipment parts, and on the testing, facilities, etc., of these equipment parts.

(3) Results of Research Entrusted in Fiscal 1985 (Outline of Interim Report)

(a) Electric Power Central Research Institute

The Electric Power Central Research Institute carries out research on the replacement of equipment parts in nuclear power stations with new ones and on the contents and actual conditions of the replacing work carried out during periodic inspections. It also summarizes user needs.

(b) New Material Center

The New Material Center abstracts new materials as candidates for adaptation to equipment parts for LWR's, and investigates their adaptability.

(c) Plant manufacturers

Plant manufacturers are summarizing the items concerning the improvement and development of LWR equipment parts required by the nuclear power station side, and are performing physical property tests of new materials such as carbon-carbon composites, short-fiber reinforced metals, fine ceramics including coating work, crystal control alloy, etc.

(4) View of Test and Research in Fiscal 1986

According to the business program for fiscal 1986, research and development of 56 articles will be carried out at a total cost of Y1.36 billion. Part of the research and development work is given below:

(a) Research and development of new materials

The corrosion resistant and wearing properties of various pumps, such as seawater pumps, can be enhanced, and the life span of these pumps lengthened by using improved stainless steel, fiber-reinforced plastics--such as alumina, silicon carbide, and silicon nitride--and rubber modified with a reinforcing material, etc. The corrosion resistance and durability of seawater piping and tube fittings can be enhanced by spraying an anticorrosion metal on the inside of the pipes, composite steel pipe technology, and a technology for adapting a winding type molding of resin-coated fiber, etc. The amount of cobalt generated from the primary system of nuclear reactors is minimized by using technologies for applying a surface hardening agent or coating various ceramics to in-pile structures and valve sheets. The corrosion resistance and specific strength of low pressure turbine blades can be enhanced by using technologies for adopting titanium alloy, long-fiber reinforced metals, various ceramics, etc. The corrosion resistance, durability, and wearing properties of various facilities of radioactive waste disposal systems can be enhanced by using technologies for adapting various ceramics, fluorocarbon resin materials, etc. The life span of mechanical seal members and packings of pumps used in chilled-water nuclear reactor systems can be lengthened, and the wearing properties of these members and packings enhanced by using technologies for adapting short-fiber reinforced metals, silicon carbide, silicon nitride, carbon-carbon composite materials, etc. The life span of parts for control rod driving units can be lengthened, and the wearing properties of these parts enhanced by using technologies for adapting various fine ceramics, super-engineering plastics, etc.

(b) Design, evaluation, and research on equipment parts

The conditions of design, environments, specifications, etc., are clarified with a view to adapting new materials to dynamic and static equipment parts. The conditions for evaluating and testing adaptability are stipulated uniformly. A cobalt-60 testing facility is being completed in order to conduct evaluations and tests in the atmosphere irradiated of LWR's.

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NONFERROUS METAL INDUSTRY'S HIGH-TECH STRATEGY DISCUSSED

Tokyo KOGYO ZAIRYO in Japanese Aug 86 pp 94-96

[Text] What is the most critical matter for the nonferrous metal industry for the coming 10 years?

The most critical matter for nonferrous metal companies for the coming 10 years is the development of profitable areas which replace nonferrous metals. There is an accelerated strategy to get "out of nonferrous metals." A common target among nonferrous metal companies is the challenge to develop new materials, especially electronics materials, and, at the same time, to take up and focus on a long-term research and development and commercialization strategy in a distinctive field which distinguishes one company from others.

It is thought that since 1985 a program to reach the target has become a model development strategy for companies of the industry in order to promote high-technology.

There are some companies which placed emphasis on electronics material and have a promising future. This paper gives examples and discusses mainly the development of long-term planning including organization and goals.

Mitsubishi Metal Corp. evaluated as a success moving out of nonferrous metals:

The high-tech strategy by which each company strives to be out of nonferrous metals means cultivation of a new technology in a distinctive area of technology which other companies lack. Especially if a new technology is highly advanced and is large scale in a special field, it will give rise to profits which are denied to other companies which follow. Among six nonferrous metal companies, one good example is Mitsubishi Metal Corp.

Mitsubishi Metal Corp. went into electronics material early and created a profitable business using powdered metal technology in both new material and process. Fifty-five percent of before-tax profit is from the new material and processing sections. Dependence on base metal is reduced yearly. Thus, Mitsubishi Metal Corp. is evaluated as a winner in the strategy of moving out of the nonferrous metal business.

Mitsubishi Metal Corp.'s main strategies for long-term research and development and commercialization in the late 1980's are focused on electronics and technology related to nuclear power. In this paper, the former is discussed.

It was in 1973 that Mitsubishi Metal Corp. clearly decided to move out of metal mining. Mitsubishi Metal Corp. dropped Mining from its previous company name, Mitsubishi Metal and Mining. This indicates that Mitsubishi Metal decided to develop a new material business with an emphasis on metals. Mitsubishi Metal Corp.'s core technology was nonferrous refining technology which successfully used related technology and application technology for commercialization. Mitsubishi Metal Corp.'s ability to digest anything is similar to that of an amoeba.

Mitsubishi Metal Corp.'s research and development system is seen to be what made success possible. Mitsubishi Metal Corp. quickly moved to reorganize the R&D organization as well as the central research laboratory to prepare for high-tech. The reorganization which became a pillar of the development system in the late 1980's was carried out from 1984 to 1985. As a result of the reorganization, three centers, the compound semiconductor center, the merchandise development center, and Naka nuclear development center, and new material business section were created.

It is characteristic of these centers that each center's director is entrusted with broad authority and can do what he wants. In certain circumstances, he can prepare for commercialization including marketing activities. Results will be evaluated some years later. This can be viewed as a venture development business inside the company. This is a unique organization for Mitsubishi Metal Corp. and it is expected that this method will be used through the latter part of the 1980's.

This strategy to strengthen the development area is based upon the STAR planning of a 5-year management plan of which 1988 is the last year. The development strategy for the year 1995, which succeeds the STAR plan, establishes major areas for compound semiconductors (electronics), new material (electronics), product processes, and nuclear power.

Electronics material on which Mitsubishi Metal Corp. placed emphasis, as well as the nuclear power field, are both making profits. Mitsubishi Metal Corp. succeeded last year in developing low alpha ray in which the amount of uranium and thorium is reduced to be PPB order, and in commercialization of alloy materials of terbium and iron used as a film material which is critical for the optical magnetic disk, a next generation recording medium.

Mitsubishi Metal Corp. has been putting a lot of effort in improving technology to obtain monocrystalline indium, phosphorous and gallium arsenide in the compound semiconductor field. Study of applications for new functional materials such as super powdered material, super plastic material, and ceramics which are beyond conventional metal processing, is a critical subject for both the new material business section and the merchandise development center.

Mitsubishi Metal Corp.'s fundamental policy in the latter part of the 1980's is to commercialize soon and steadily any promising R&D subjects by using the intracompany venture business.

Mitsui Metal and Mining made inroads into five fields including electronics material excluding silicon.

Mitsui Metal Corp.'s strategies for long-term R&D, and commercialization in the latter part of 1980's are focused in five fields: the electronics related field such as electronics material, new material field, battery material field, parts and processing field, and engineering field.

Mitsui Metal Corp.'s strategy is to commercialize subjects from these fields as soon as possible. A project team method is adopted to achieve this. Mitsui Metal Corp.'s project team is different from other project teams because the project team has exactly the same organization as the research department and is engaged in management and manufacture of prototypes. If a project looks promising, a project team is changed from a research section to a business promotion section. The business promotion section is a small operating division. When sales reach a certain scale, it continues to function as an operating division.

Results of this type of project team have been apparent since 1985. Three project teams, FPC, thermistor, and metal magnetic powder, were established during the 2 years of 1982 and 1983. In 1983, the thermistor and FPC project teams were raised to business promotion section, and shifted from the research and development office to become an organization under the direct control of the company president. They are expected to make profits this year.

In electronics material, Mitsui Metal Corp. is already engaged in copper foil which is a circuit material, conductive paste, and magnetic material such as carrier iron powder and metal iron powder and in developing new material. Mitsui Metal Corp. succeeded in commercialization of alexandrite, which is an oxide single crystal, as an applied product of rare metal and rare earth which was developed by the Miike office. Since this crystal technology can be applied in other fields, Mitsui Metal Corp. is promoting R&D for an array of other single crystal products.

Mitsui Metal Corp. had positioned the thyristor as a ceramic electronics material and is planning to develop ceramic electronics material other than thyristors.

A material which should be commercialized as soon as possible due to consumers' needs is a battery material. Mitsui Metal Corp. and Toho Zinc Co., Ltd., have been working on development of a cathode material to reduce the mercury content in an alkali dry cell battery. They are planning to complete development of a material in which the mercury content is 1.5 percent (currently it is 3 percent).

One reason Mitsui Metal Corp. is not including silicon in its electronics materials is the severe competition which Mitsui Metal Corp. believes makes it difficult to get ahead of other competing companies. Their policy is to develop a new business which is a combination of electronics material and the company's own distinctive field.

Hitachi Metals Ltd. promotes high value-added basic electronics materials.

Hitachi Metals Ltd.'s objective in the 5 year plan which started in 1985 is to increase sales of electronics material to 30 percent (22 percent in 1984). The RD-5 (R&D 5-year plan) which simultaneously started with the 5-year plan is to strengthen the R&D system to achieve the goal. Investment in R&D will be gradually increased from ¥5.6 billion in 1984 to twice that amount in 1989. They also plan to double facilities and manpower during the 5 years.

Based upon this plan, another metallurgical laboratory, which engages in basic research on all metal material, was created in October 1985. However, the magnetic material laboratory mainly engages in developing electronics material. There are many projects which can soon be commercialized. Examples are compound semiconductor materials such as gadolinium-gallium-garnet (GGG), and large capacity thin magnetic disks, developed at the request of the New Technology Research Development Corp. of Japan. This new technology is a spin-off from Hitachi Metal Corp.'s permanent magnet technology which has been developed since the founding of the company.

The foundation for the technology for electronics materials which are produced by this company is shaped by the development of magnetic head material. The final development of this technology is a thin film magnetic disk which is currently being developed. A magnetic disk is made by creating a magnetic film by spattering on a precision-polished aluminum wafer. This disk can hold more information and has a shorter searching time than a floppy disk. It is expected to be a new external memory device to go along with the increased distribution computers.

Total sales will not increase unless there is much development of high value-added products in the electronics material field. Thus, the magnetic disk is one step ahead of existing electronics material and parts and is a final product. To that extent, it is very critical to have a sales system which has even closer contact with users.

Nippon Mining Co., Ltd. is most successful among major nonferrous metal companies in moving out of nonferrous metals, even though its sales from nonferrous metals are 30 percent.

Nippon Mining Co., Ltd.'s two main avenues for moving out of nonferrous metals are electronics material and biotechnology. In this paper, only electronics material is discussed.

In the electronics field, they succeeded in production of a prototype and began shipping samples of a single crystal of indium-phosphorus and a single crystal of cadmium-tellurium, made with the rare metal collection technology which is a byproduct of nonferrous refining. Their objective is to create a compound semiconductor and oxide semiconductor. They plan to research in detail practical application of the III-group and V-group compounds as well as II-group and VI-group compound semiconductors.

Based upon their forecast that technology for integrated semiconductors must be at the 1M (mega) level, the electronics material and parts laboratory became independent in April 1984 and full-scale R&D has begun.

Their research in electronics material includes a wide range of areas such as lead frame material, copper alloy and 42 alloy, and optical communication equipment for the opto-electronic peripherals.

Among them, the same company established a development strategy in late 1985 and examples of key strategies for development are optical communication and copper foil lead frames. In this field, Nippon Mining Co., Ltd., made technical agreements with foreign companies in 1985. They made an agreement with an American company, Gould, for import sale of an optical coupler in the fall of 1985 and will be engaged in full-scale sales. The objective is to develop an optical fiber communication system with the cooperation of Tatsuta Electric Wire & Cable Co., Ltd., an affiliate of Nippon Mining Co., Ltd., and they plan to modify Gould's technology to suit the Japanese market, thus becoming an optical communication manufacturer in the future.

In the lead frame field, they made a capital investment in an American company, Colton, and will make it a base from which to collect American information on technology, especially high-tech information.

A company to sell Nippon Mining Co., Ltd.'s electronics material related products, NIMIC, was founded in the United States and started business in January 1986. Nippon Mining Co., Ltd.'s plan is that NIMIC will not only import their products but also export American products to Japan. NIMIC will function as a "watcher" of new technology for electronics and biotechnology.

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MITSUI TOATSU PROMOTING DEVELOPMENT OF NEW POLYMER PRODUCTS

Tokyo TOSHI KEIZAI in Japanese Jun 86 pp 60-61

[Text] New Lines of Business Targeted at ¥150 Billion

The zooming increase of the yen value and the sharp drop in oil prices have been causing confusion in the Japanese chemical industry, which has been experiencing a transition toward a new pricing system. Despite drastic decreases in raw material and fuel costs, it is inevitable that the Japanese chemical industry switch over its structure from being commodity oriented to specialty oriented.

"Bulky petrochemical products, although not expected to increase in quantity easily, will not cease to exist. In addition, the chemical industry, unlike some structurally depressed industries, has extensive diversifying, fields of application. Each of us is enriching specific lines of business based on specific strong points and features. Each chemical company should focus on specific fields commensurate with its own skills, rather than handling the same fields," says President Sawamura of Mitsui Toatsu Chemical Co., defining the direction to be taken by the company.

The availability of a variety of raw materials, monomer synthesis, and polymerization technologies fostered within an integrated chemical industry environment, and Mitsui Toatsu's unique technologies, such as processing, mold processing, paint fabric, paint film, adhesion, surface treatment, color material, and foam-open fabric [as published], combine to form the fundamentals.

The medium-range business plan calls for new business sales of ¥150 billion; ¥60 billion for new raw materials, ¥55 billion for electronic materials, and ¥35 billion for biochemical products. Functional polymer is a major item among the new raw materials and provides the most familiar business and one that produces quick results.

The functional polymer development division, which started up last July and later acquired the compound material and plastic magnet business from the development division this April, now consists of three marketing departments and three rooms (a special film development room, compound material development room, and development room), and is staffed with about 60 people. The division's sales amount is currently about ¥5 billion but is being pressed to reach ¥10 billion as soon as possible.

Emphasis on Super-Engineering Plastics

Products handled by the functional polymer development division which contribute to the division's achievement include PEEK and PES (engineering plastics), gas barrier resin (balex), special phenol resin, phenol pipe, and hot-melt nonwoven fabric.

The resin materials of PEEK (polyether etherketone) and PES (polyether sulphone) are imported from ICI of Great Britain and are processed for marketing in Japan. There are plans to set up a joint venture company to manufacture these products on a 100 percent Japanese-made basis.

PEEK, with a heat resistance of about 250°C, and PES, with a heat resistance of about 180°C, are highly chemical- and environment-resistant (hot water, acid, alkali, various solvents, radioactive rays, etc.), and excel in mold workability. They have been finding applications in electric insulation materials, electronic components, mechanical parts, and automotive parts.

Mitsui Toatsu had developed original technology that can provide film-form PEEK and PES and is marketing them as a TALPA series. They have far better characteristics than polyester films. Because of their heat resistance almost equal to that of polyimide films, environment resistance, and electrical characteristics, they are expected to be used in electronic fields (insulation, acoustics, information) and in composite fields (vehicles, aircraft).

Balex, which is currently being imported from the Sohio Co. of the United States is to be produced at the Nagoya plant with an annual production capacity of 3,000 tons starting this June. It is an acrylonitrile thermoplastic resin that does not easily allow oxygen or carbon dioxide gas to permeate and has excellent chemical resistance. It is used for food packaging materials and various chemical and solvent containers, as well as for secondary processing products including molds, sheets, films, and plates.

Integrated Deployment of Phenol Resin

Special phenol resin can be called a new engineering plastic that uses a dramatic denaturating method to overcome the disadvantages--poor workability and fragility--of thermosetting resin. It has good heat- and chemical-resistance and durability, and can sometimes replace expensive polyimide resin. Applications in automotive parts, electronic components, and industrial materials are rapidly increasing. In addition, the development of a high-speed, continuous-extrusion, molding technology for phenol resin has made possible the production of semipermanently durable, low-cost phenol pipes and rolls, and has permitted the alternative use of iron pipes. Thus, an expanded setup supporting an integrated phenol family has been implemented.

Hot-melt nonwoven fabric, which has been developed based on the original foam-open fabric and processing technologies, serves as adhesive and glue as well. Because of its air-permeability and soundproof effect, it is widely used for automobiles, electric machines, construction, shoes, and padding. Based on the considerable market share Mitsui Toatsu had in paper diaper nonwoven fabric, the hot-melt type has been developed to find new application.

Other resin-processing products include air-permeating film, heat-ray intercepting film, (IC-dizing) film, and backgliding film. The air-permeating film marketed last year is a low-cost resin based on processing techniques used for polyethylene and polypropylene. It admits gases but not water providing good ventilation. It can be used for waterproofing coats and disposable diapers, and sales are expected to reach ¥5 billion in 5 years.

Heat-ray intercepting film with glass-quality transparency is expected to be used in combination with multilayer glass for heat insulation and insulation in freezer-refrigerators and showcases. It is imported from the Southwall Co. of the United States and marketed here.

Ultra-Heat-Resistant Adhesive Commercialized

Polyimide heat-resistant film, LARC-TPI, is a highlight among special films currently provided. This adhesive, with a heat resistance of 300°C, is technically affiliated with NASA and will find a variety of applications in space development, aircraft, and electronic components. It has made feasible adhesion between metal and metal, composite and metal, polyimide and metal, or ceramics and metal.

Additionally, in combination with carbon fiber or glass cloth, it can form prepleg to allow its application as a composite for structural material, providing a dramatically new functional material. It is a highly value-added product, costing several ¥10,000 per kilogram.

Other special films for which a demand is being developed mostly in food areas include an ultrafiltering membrane introduced by the DDS Co. of Denmark, a reverse osmosis membrane, and a gas separation membrane system. In addition, polarization film with excellent durability and weather-resistance is to be used for liquid crystal display panels and outdoor displays and an electrically conductive film is to be used for electronic packages.

Meanwhile, compound materials have proven applications such as the FRP-type estertray, esterwagon, and parabolic antenna, as well as SMC, BMC, and their molds. Recently, a light plastic material, SLMC, for automobile body outer plate has been developed in cooperation with Suzuki Motor Co., Ltd.

It is about 20 percent lighter than SMC (sheet molding compound) and 40 to 50 percent lighter than steel plate and excels in surface finish and productivity. It received the highest prize for excellence in the transportation department from the U.S. Plastic Industry Federation.

Finally, plastic magnet and coating material for optical fiber is handled by the development room.

Different kinds of resins, ferrite, and rare earth magnet alloys are mixed, melted, and molded to produce plastic magnet. In this way, very complex shapes that conventional magnets cannot form can be molded with high accuracy, and more compact and lighter products have become available. Mitsui Toatsu,

which has established a quantity-production die technology and high-performance quality control technology, is finding applications in automotive parts, micromotor parts, magnetic therapy parts, etc.

Ultraviolet-setting coating material that protects optical fiber has been developed. The coating material is significantly less costly in terms of productivity and raw materials than conventional silicon and nylon coating materials, and is to be put into commercial production as a material dedicated to subscriber-type optical fibers.

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CERAMIC COATING TECHNOLOGY DISCUSSED

Tokyo NIKKO MATERIALS in Japanese May 86 pp 1-6

[Article by J. Sasaki, General Laboratory of Mitsubishi Chemical Industries, Ltd.: "Ceramics Coating"]

[Text] Within the ceramics industry, highlighted as the center of new material development, ceramic coating technology, though undramatic, is steadily building its own position.

When one uses a material that is subject to any deterioration phenomena--corrosion, abrasion, etc.--you need a coating material to protect the base material so that the base material will not lose its inherent characteristics. Needed for such protection are ceramic materials that are highly resistant to heat, abrasion, and corrosion. At the same time, it is necessary to maintain the natural condition of the base materials through the use of a thin membrane coating.

Coating technology can be described as thin membrane production technology. At present, a number of thin membrane production technologies are available, most of which are used for ceramic coating. Some thin ceramic membranes, such as ZnO piezoelectric film and PLZT film, have active functions, but this article will be devoted to those designed to perform a protective function.

1. Material Design for Ceramic Coating

Today a great number of methods are used for ceramic coating, and various approaches--from the enamel production process with a long history to the more recently popular spattering and ion-plating techniques--are employed. The phenomena involved in the coating process are complex, and the physical behavior and chemical nature of membranes with a thickness on the order of microns have by no means been fully clarified. Current technology developments seem to be based on past experience, but following recent improvements in the physical vapor deposition system, progress in technologies to analyze the condition of plasma, and upgraded technology to analyze thin membranes, we are going to get the foothold for the material design.

Material design should fundamentally envisage several types of production methods and include a design for a comprehensive process down to the final product, including the material's conditions and reactions as well as adjustability between different kinds of materials. In this regard, ceramic coating can be done by various methods and it is difficult to decide which one should be selected. For these reasons, I will list the physical properties needed for the base material and the coating material as a point that should be taken into consideration when selecting coating methods, although such guidance may deviate somewhat from orthodox material designs.

Base Material:

--Melting point

--Heat expansion rate

--Steam pressure (gas volatility, hydroscopicity)

--Elasticity coefficient

--Reactiveness

--Surface condition (presence or absence of inactive membrane, condition of contamination), etc.

Coating Material:

--Melting point

--Heat expansion rate

--Extensibility, compression strength

--Elasticity coefficient

--Chemical stability

--Gas insulation against gas and liquid, etc.

The above comprise the basic requirements.

In addition to these requirements, a number of physical parameters such as hardness (for super hard tools), transparency (for transparent electricity conductive membrane), elastic conductivity (electricity insulation membrane), and low heat-conductivity (thermo barrier coating) are needed for special applications. When examining these physical parameters, a judgment should be made with consideration given to adjustability between the base material and coating material. The coating process should also be borne in mind. For instance, if chlorine gas is present with an aluminum base material in the CVD method, the gas would react with the aluminum, making its use inappropriate.

In selecting a method it is important to comprehensively evaluate the utility of each method from the technological and economical points of view. It is also necessary to obtain the latest information because the shortcomings or limits of respective methods are presumably being overcome day by day.

2. Present Status and Future Trends of Ceramic Coating

Among the ceramic coating technologies presently in use, I will discuss, with my personal view on some points, the requirements and methods whose needs are expected to grow in the future. For those that have practical applications, I will attempt to cover their material design as well.

(a) Severe Use Environment

In the case of ceramic engines, the expected advantages of using ceramics include improvement in heat efficiency by raising the operating temperature (particularly conspicuous with the gas turbine engine), elimination of cooling water through the use of heat insulating ceramics, and weight reduction. On the other hand, it is also true that the ceramic engine has several problems today, such as the low heat-shock resistance of ceramics.

The same can be said for ceramic coated materials. Being made of ceramics, they are highly touted for their heat resistance and chemical stability among other properties, and their required use environment is becoming more and more severe. In terms of material design, the point would be how to solve the problems inherent to ceramics when used in severe environments.

The heat insulation coating (thermo barrier coating--TBC), with a history of more than 30 years, has been developed mainly in the United States as a high temperature material for use in gas turbine engines for space and aviation vehicles. The primary purpose is to use heat-resistant super alloys at a higher temperature and to protect them from high temperature corrosion and erosion. In the earlier days of the development, SiO_2 was used, among other compounds, but they demonstrated little effectiveness. The material which exhibited a special effect as a TBC was Y_2O_3 stabilized ZrO_2, a material with a heat conductivity as low as one-tenth to one-twentieth that of the super alloys.

Today, from the viewpoint of material design, coating is performed by means of plasma spraying to achieve the following:

Heat insulation }
Crack resistance }: ZrO_2 partially stabilized with Y_2O_3

Corrosion resistance: NiCrAlY alloy liner

Erosion resistance: Increase surface density of Y_2O_3 partially stabilized zirconium.

Observation of the microstructure of the above membrane reveals that the material design is conducted in more detail. That is, the YSZ layer is made of a pillar structure to help alleviate the stress and cracks caused by the heat cycle along with the pores that are present at a rate of 10-15 percent. While the presence of the YSZ layer itself serves to block corrosion by NaCl, etc., at high temperatures, the antioxidation blocking for oxidation resistance is addressed by the AlO_3 layer formed by oxidation on the surface of NiCrAlY. The AlO_3 also helps improve the adhesiveness of YSZ and NiCrAlY. Its surface is made rough so that microcracks will not spread on the surface, resulting in detachment of the interfaced planes.

Besides plasma spraying, the electronic beam vapor deposit has recently attracted attention as a means to form TBC membranes. In the electronic beam vapor deposit, an oxygen deficient ZrO_2 layer is formed on the Al_2O_3 layer at the early stage of the deposition, and the ZrO_2 layer becomes strong attached to the interface. Because of this, making the surface smooth does not cause a problem in strength but does reduce the space exposed to corrosive gas. Thus the electronic beam vapor deposit is advantageous in terms of corrosion resistance and may replace the current plasma spraying.

The above discussion may have been somewhat too detailed, but should help make clear that in the material design of ceramic coatings it is important to correctly characterize not only the material itself but also its microstructure and surface condition. As exemplified by the TiC coating on the interior wall of the high temperature plasma container for the critical plasma experiment system, ceramic coating is highly regarded whenever considering materials to be used in an extreme environment.

(b) Low Temperature Process

Except for the consideration of resistance against heat cycles, it is desirable to be able to form a dense and strong adhesive membrane at a low temperature, because the low temperature process makes it possible to form membranes on materials with a low melting point, such as plastics, and thus widens the selection range for base materials. Ion plating is employed to coat the steel used in high-speed tools because the steel deteriorates when the temperature reaches 500-600°C, making it impossible to employ CVD, a process performed at 800-900°C.

In general, lowering the process temperature is being achieved by shifting the method from heating the base material to raising the temperature of, i.e., to activating, the coating material to a gaseous state before it is precipitated. (Plasma is usually used for the activation.) In other words, the trend is: Heat CVD → plasma CVD, vapor deposition → ion plating.

In the spattering method, the process temperature can be lowered by using a magnetron, which prevents high energy electrons from clashing against the substrate and thus prevents heat.

Lowering the process temperature by activating the coating material is obviously effective in achieving density and adhesiveness, because the method induces mixing and reactions at the interface with the base material. But with high energy particles being quenched on the surface of the base body, it is undeniable that the properties achieved by this method are, to a certain extent, inferior to those realized by heating the base material. The ultimate objective should be to determine the compromise point between lowering process temperature and achieving desirable membrane properties. From the point of view of material design, there are also a number of points to be addressed, such as surface treatment of the base body.

To lower the process temperature, the sol-gel method is attractive in terms of operationability and cost. By this method, however, it is hard to form a thick membrane and the formed membrane tends to be porous. Therefore, the sol-gel method will be developed with more interest for functional inorganic thin membranes, such as catalyst carriers, than for protective coating.

In addition to the above, optical energy is also used to activate the previously mentioned reaction species. But many of these processes are still in the research stage, and I will not cover them in this article.

(c) Growth of Reaction Membrane

While ceramic coating materials are chemical compounds, increasingly the materials to be coated are also chemical compounds. In material design, coating the chemical compounds is indispensable in order to widen the range of choice for materials.

In general, when chemical compounds are used as a source of evaporation, membrane composition varies widely and the membrane thus formed is not good in its properties. The super hard TC membrane, for instance, has a hardness of 945-1615 kg/mm^2 when directly deposited, while an activated reaction deposition using Ti steam and acetylene gas can form TiC in stoichiometric composition and achieve a hardness of 3,000 kg/mm^2 or more.

Thus with a reaction membrane coating it is possible to control the composition. When composition can be controlled, it is often possible to continuously control the physical properties of the membrane. Thus this method should also be effective in forming functional thin membranes.

In the spattering method, reaction spattering is increasingly used. This method not only makes it possible to control composition, but also has many other merits such as making DC spattering possible by using metal targets and eliminating costly chemical targets.

(d) Coating Plastics

Coating plastics has long been done primarily for purposes of ornamentation. However, the recent advent of plastic parts in precision optical devices has created a need for ceramic coatings to meet severe requirements.

Plastics are high polymer chemical compounds composed primarily of carbon, hydrogen, and oxygen. While they have the advantage of being easily molded, their disadvantages include poor heat and abrasion resistance. The major purpose of coating plastics with inorganic material, however, is to prevent moisture absorption. Organic membranes will do just enough to improve abrasion resistance, but organic membranes have moisture permeability and hygroscopicity, though in varied degrees.

When coating plastics with ceramics in dry processes, the low heat resistance, hygroscopicity, and heat expansiveness of the plastic are troublesome. A solution to this problem is urgently needed in order to devise protective coatings for optical magnetic discs.

The optical magnetic disc is being aggressively developed at present as a reloadable memory device. One of the problems in its development is the protection membrane. The optical magnetic disc uses polycarbonates or acrylic resines as its substrate. A membrane of rare earth transition metal alloy (RE-TM membrane), which is less than 1,000Å in thickness and prone to oxidation, is used for recording. The disc performs optical recording/recovery/deletion all through the substrates. Since plastics have hygroscopicity and water permeability, direct coating of the RE-TM membrane on the substrate results in oxidation of the membrane due to the presence of oxygen and water in the substrate. Thus it is necessary to cover the both sides of the RE-TM membrane with a protective membrane to completely shut out the outer air.

The requirements for such a protective membrane are stringent, including complete gas insulation, transparency, chemical stability, nonreactivity with the recording membrane, and also a high refractive index.

At present, spattering coating is mainly employed as a dry process. With consideration given to the previously stated problems involved in plastic coating, research is under way to seek solutions to many problems, such as low temperature coating, degasification of the substrate, occurrence of cracks due to different expansion rates of the substrate, and a protective membrane that must undergo the temperature gap between coating temperature and normal temperature, as well as the expansion associated with moisture absorption.

As stated above, a protective membrane for optical magnetic discs is considered to be very important in the trend of ceramic coatings for plastics.

Apart from what has been stated, there is a report that says a SiO_2 and PTFE (polytetra fluorinated ethylene) mixed membrane is effective in protecting polymide film from oxidation by active oxygen in the space while simultaneously maintaining the film's flexibility. Hybrid coatings of organic and inorganic materials may find interesting functions in future.

(e) Increased Property Requirements

In the future, ceramic coatings will not be required to perform only a single function (i.e., a protective function), but multifunctionality will be increasingly required. The previously discussed protective membrane for optical magnetic discs is a classic example of this multifunctionality.

It may turn out that the plurality of requirements will be met by using coating ceramics in multiple layers or using blended ceramics.

3. Conclusion

As discussed above, the field of ceramic coatings has become both too wide and too specialized to be explained easily. As a general trend, the dry process seems to be the mainstay, while other methods not discussed in this article, such as the sol-gel method, are also very promising.

The most important element in continuing ceramic coating research and development is not only to improve the methods but also to strengthen analysis technology in order to clarify the composition, microstructure, and surface of the coating membrane itself. In addition, as the temperature at which the coating is performed is becoming increasingly lower, the membrane itself often becomes amorphous. This makes it necessary to upgrade the procedures for analyzing material conditions.

When ceramic coating is considered as a business, we find that enterprises specialized in coating services are starting to appear. With its diversified applications and huge potential for technical development, as well as the marketability of software techniques, this business seems to have great prospects.

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MITI'S 21ST CENTURY NUCLEAR ENERGY VISION ANNOUNCED

Tokyo GENSHIRYOKU SANGYO SHIMBUN in Japanese 24 Jul 86 pp 1, 4-5

[Text] Nuclear Energy Group of the Comprehensive Energy Investigative Committee Announces 21st Century Nuclear Energy Vision

Towards a Fixed Nuclear Fuel Cycle

Outlook for 2030: Nuclear Energy to Hold a 60 Percent Share

The Nuclear Energy Group of MITI's Comprehensive Energy Investigative Committee, on the 18th, completed its report entitled "Nuclear Energy Vision: Considering the Nuclear Energy of the 21st Century." Taking a look down the road 45 years from now at 2030, the report projects the future picture of our country's nuclear energy development. Accordingly, this vision paints a hitherto unseen picture of "nuclear energy generation comprising 60 percent of the total electricity output by 2030." As far as the development strategy of the future is concerned, the report labels the next 25 years as the "nuclear fuel cycle establishment and settlement era," and the subsequent 20 years as "the FBR [fast breeder reactor] commercial use era." The report emphasizes that there is a need to plan for new developments by making positive use of private sector abilities." Moreover, with regard to internationalization, the report brings to the forefront the idea that "there is a need for Japan, as one of the world leaders in this area, to take the lead in the peaceful uses of nuclear energy."

(Summary of the Vision pages 4 and 5 [see below].)

Using the Private Sector Positively

This Vision at the outset makes the following forecast about the scale of nuclear energy development in 2030, "in that year, the scale of Japan's nuclear energy, at its high, will reach 137 million kw, or about 5.6 times the present amount."

This is a calculation that nuclear energy will then comprise about 58 percent of all electricity output and will make up about 27 percent of all primary energy. This calculation also concludes that "the number of nuclear energy facilities will reach about 112."

In the midst of this, the report, based on the awareness that "future Japanese nuclear energy technology will reach the highest level in the world," points out that with regard to future development strategy, "Japan's nuclear energy industry has entered a period wherein it will switch from being a "special industry" to an "ordinary industry." Based on this thinking, the report sets forth the fundamental strategy of "the need to work even harder to provide a cheap and excellent supply of electricity, under the overriding principle of guaranteed safety, by using the private sector positively."

Specifically, the report stresses the importance of working for new developments by labeling the 25 years up to 2010, "the nuclear fuel cycle establishment and settlement era" and the 20 years between 2010 and 2030, "the FBR commercial use era."

With regard to nuclear fuel cycle strategy, the report makes known the policy that "We will proceed as planned to establish the Shimokita nuclear fuel cycle facility." In addition, the report states that with regard to enriched uranium, "We will supply 6,000 tons of domestically enriched uranium, which is about one-half of the 12,000 tons needed in 2015." Furthermore, the report presents the idea that, with regard to a second private reprocessing plant, which is one of the focal points of the report, "We will aim for it to be operational by 2010."

Moreover, with regard to future reactor strategy, the report states that "We will move ahead with the strategy of advancing light water reactor technology in preparation for the prolongation of the light water reactor period." With regard to FBR, the report states, "We will work towards improving the economics of the FBR so that the construction cost of the test reactor, which should be operational by 2003, will be about 1.5 times that of a light water reactor, the cost of the first commercial reactor will be about 1.2 times the cost, and the cost of the second commercial reactor will be about 1.1 times the cost." The report notes that "by 2030, about seven million kw of electric power will be from FBR (a five percent share)."

Furthermore, the report, taking into account the Chernobyl nuclear power plant accident in the Soviet Union, reconfirms its past line that "safety guarantees come first," and has devised a policy to promote "a high-degree safety program (known as Safety 21)," which takes as its theme the prevention of human error.

Furthermore, the report discusses radioactive waste disposal policy, stating that "low-level waste will be handled by the Simokita facility by 2030," and offers the new idea that "Although we foresee an era of high-level waste disposal from 2030 and beyond, we are considering the possibility of disposal becoming a main responsibility of the private sector."

Finally, with regard to the nuclear energy industry, the report estimates that "its cumulative market value over the next 45 years will be around 180 trillion yen," and that "although the trend of power plant construction will continue to level off, the relationship between the management and maintenance of the plants and the nuclear fuel cycle will grow enormously... there is a need for the industry to respond to this."

[Page 4]

As stated on the first page of this newspaper, the Nuclear Energy Group of MITI's Comprehensive Energy Investigative Committee, on the 18th, announced its nuclear energy vision entitled "Considering Nuclear Energy in the 21st Century." This vision looks down the road at 2030 and postulates a future outlook for the development of nuclear energy in Japan. This report first draws the picture of a Japan "in 2030 when about 60 percent of the entire electricity output is supplied by nuclear energy generation." After that, the report stresses that "Japan, in the future, must take the lead in the peaceful use of nuclear energy as the frontrunner in the world in this field." What follows is a summary of this vision.

Considering the Nuclear Energy of the 21st Century

Nuclear Energy Group of the Comprehensive Energy Investigative Committee's From the "Nuclear Energy Vision" to an Advanced Safety Policy;

Promoting "Safety 21"

As a result of promoting guaranteed safety as the overriding principle, Japan's generation of nuclear energy has achieved a level of safety that is the highest in the world today.

However, our nuclear energy authorities always maintain "a modest attitude" and are never complacent about the safety operations record of the past 20 years. Of course, they make sure that the lessons from domestic and foreign accidents, including the Chernobyl nuclear plant accident in the Soviet Union, are accurately reflected in our own safety guarantee policies, and they continue to make every effort to raise the level of safety higher since they must respond to the trust of the nation.

Consequently, these authorities, have decided to draft "An Advanced Safety Program - Safety 21," which aims to guarantee fully the safety of nuclear energy in the future, and to implement this with industry, academe, and government working in unison.

The aims of Safety 21 are: (1) The perfection of safety regulations by the nation; (2) The perfection of integrity by the entrepreneurs; (3) The promotion of research and technological development in order to increase safety; (4) The perfection of emergency measures; and (5) The promotion of international cooperation with regard to safety. The following strategies are being carried out with regard to the perfection of safety regulations by the nation.

1. Improving Safety Regulations

Devising effective and efficient implementation of further improvements of the technological standards of a nuclear power plant and the administrative supervision of the operations of that plant by aggressive introduction of the latest knowledge and using information and experience accumulated through licensing and inspections that have taken place up to now.

2. Responding to New Fields

Improvements of technological standards should be advanced in a planned fashion by responding to the commercialization of new type reactors, making concrete nuclear reactor abandonment measures, and commercializing the nuclear fuel cycle.

3. Responding to Increased Business

As the number of nucler power plants increase, we must make uniform the operating of the safety regulations of the nation, such as inspections, by actively using third party expert organizations.

Moreover, with regard to the research and technological development to raise the level of safety, we will further the following research.

1. Research and Technological Development of the Prevention on Human Error

We will carry out the "research of human factors," which is research on the deportment of human beings during normal times and emergencies, and the "development of operational assistance systems," which applies the most relevant man-machine interface and knowledge engineering.

2. Technological Developments to Prevent Unforeseen Accidents and Incidents

We will develop technology which will be able accurately to inspect, diagnose, and evaluate the status of deterioration of equipment that has been operating in a plant for many years.

3. Research into the Conduct of Nuclear Reactors

We will promote the continuation of analytical research regarding the conduct of nuclear reactors under conditions of an assumed severe accident.

Emerging as an "Ordinary Industry"

Light Water Reactors Reach the Highest Level in the World

Japan achieved two records in nuclear energy history in 1985.

The first was a facility efficiency utilization percentage of 76 percent, the highest in the history of nuclear power plants. When we consider the regular inspection system of our country, this means that the capacity utilization rate is really close to 100 percent, and signifies that nuclear energy generation is settling into a stable period.

The second was the fact that the percentage of nuclear energy generation comprised 26 percent of all electric power supplied, the first time it was above oil-fired electricity generation which stood at 25 percent. Thus, the curtain has opened on the era where "nuclear energy is primary, and oil is secondary" in electric power generation. As for overall primary energy, nuclear energy

can be said to occupy a place alongside coal and natural gas as an alternate energy to petroleum.

However, with the sluggishness of energy demand in recent years and the progress in the development and introduction of alternate energies to petroleum, we have entered an era of "energy competition" among nuclear energy, oil, coal, and natural gas.

Moreover, from the perspective of a "comprehensive energy policy," which includes oil, coal, and natural gas, nuclear energy will play a considerable role in the long term, and we have been seeking to make clear the forecast of the contribution it can be expected to make to the supply of energy in the future.

Furthermore, in the past, Japan has furthered the development and commercialization of nuclear energy generation and the nuclear fuel cycle. For the future, on the basis of forecasts about the supply and demand of new uranium and the development of FBR and reprocessing technology, we will seek, from the standpoint of nuclear energy policy, ways to increase comprehensive performance of nuclear energy by coordinating the nuclear power generation field and the nuclear fuel cycle field.

Nuclear energy has reached the stage of being a genuine alternative energy to oil in our country, and is moving from a "special industry" in the research and development stage to an "energy industry," which as an "ordinary industry," and operates on economic principles. Therefore, we are entering an era wherein the policy for nuclear energy is shifting in a direction that draws on the activity of an "energy industry" in accordance with policies emphasizing its aspects as an "ordinary industry."

With this sort of background, this "Nuclear Energy Vision" was put together after the study of a comprehensive and long-term framework which considered the future course of nuclear energy in terms of its relationship with other forms of energy.

Nuclear Energy's Share: About 60 Percent 45 Years Hence

Emphasis on FBR and Economic Value

Long-term Outlook for Nuclear Energy

Table 1 provides the forecast for the capacity of nuclear power plants in 2000, 2010, and 2030.

Of these, Case I assumes an average annual GNP growth rate of 2.5 percent from 2000 to 2030, and using that, looks for overall electric power demand in 2030 and predicts the scale of nuclear power generation. Morever, in Case II, overall electric power demand in 2030 is sought and the scale of nuclear power generation in that year is predicted according to the anticipated population in 2030 and the prediction of the per capita electric power demand.

Case I, which predicts the overall electric power demand in 2030 from the GNP, forecasts that the overall electric power demand in 2030 will be 1.59 trillion KWH and that the nuclear power generated will be 137 billion KWH. If we assume that the overall percentage of electrification in 2030 will be 50 percent (it was 37 percent in 1984), then the percentage that nuclear energy occupies in overall primary energy supply will be 27 percent.

Moreover, in case I, the development scale of the nuclear power plants necessary in the future including replacement plants, will be 146 billion KW (122 plants). (See Table 2)

Reactor Type Strategy

In considering Japan's long-term reactor type strategy, a major task, along with emphasizing the economics, is to plan for the effective use and conservation of uranium, including the most appropriate use of plutonium and recovered uranium.

There are six fundamental points from the perspective of such a strategy: (1) Improving to the highest level the technology of the current light water reactor type; (2) Development of new type light water reactors; (3) Development of next generation light water reactors; (4) Use of plutonium by a light water reactor (plutonium thermal use); (5) Maintenance and improvement of light water reactor technology; and (6) Furthering the development of the FBR.

Reaction to the Prolonging of the Light Water Reactor Era

Raising Light Water Reactor Technology to a High Level

At the same time that a steady increase of nuclear power generation is forecast, a prolongation of the light water reactor era is predicted because of the delay in the commercial use era for the FBR. Along with this, we are working to have the private sector, while guaranteeing safety, raise light water reactor technology to an even higher level to respond to demands of the light water reactor such as increasing its economy and reliability and maintaining energy security by the conservation of uranium resources.

1. To provide a higher degree of reliability, operational capability, and economy to the light water reactor, we will carry out technology development that sees through to the entire life of the plant from design and construction to abandonment.

2. We are currently furthering the development of new light water reactors and aim for the first plant to be operational in the mid-1990's.

3. Over the long-term we are working towards the goal of beginnning to introduce about 2005 the development of the next generation light water reactor as a Japanese light water reactor that emphasizes the effective use and economy of uranium.

Plutonium Thermal Use Program

Because there is much experience with plutonium thermal use in foreign countries, one would expect that there would be no problems technologically, but from the perspective of technological confirmation of its special nature and accumulation of experience in the processing and handling of uranium-plutonium mixed oxygen (MOX) fuel, work is moving forward on its full-fledged use through the verification stage by small scale tests and commercial size tests.

Of these, full-fledged use will begin in 1997 along with BWR [boiling water reactor] and PWR [pressurized water reactor], including a schedule of the commercial verification test program.

Therefore, we are considering a lead time for licensing and fuel manufacture and have decided on actual implementation of the project in the early 1990's.

At the stage of full-fledged use, the size of the MOX fuel load will be about one-third of the reactor core. In this case, if we calculate from the plutonium demand situation in 2030, it will be possible for plutonium thermal use to be implemented in about six BWR and six PWR reactors of the one million KW class.

Incidentally, in moving toward full-fledged use, we are looking closely at both the domestic and foreign situation surrounding the use of plutonium, such as the plutonium demand situation, the economics, and the progress of technological development.

Abandonment of Nuclear Reactors

The development of technology to ensure the long life of nuclear power facilities is moving ahead, but when we make calculations by assuming that the provisional period is 40 years, the nuclear power plants that must be abandoned will total 1 million kW by 2010 and about 33 million kW from 2011 to 2030.

It is now possible to make a more complete response to the existing technology of abandoning nuclear power facilities or to improving them, but further technological developments will be advanced in the future because of a reduction of the radiation doses received by the operating enterprises and an increase of efficiency of operations.

Small and Medium Reactors

To prepare for future needs, we are studying the technological and economic feasibility of small and medium size reactors that are easy to move and maintain (including joint thermal supplies) by public and private enterprises as sites near urban areas or on outlying islands.

High Conversion Type Light Water Reactors

We will work to clarify the place for high conversion type light water reactors after considering the future uranium supply, after studying its economic and technological feasibility.

Maintenance and Improvement of Heavy Water Reactor Technology

New Conversion Reactor (ATR [Advanced Thermal Reactor])

We will move ahead with the test reactor construction program from the viewpoint of working to establish early a technology using plutonium. With regard to ATR development after the test reactor, we will evaluate and study such things as the outcome of the improvement of the design, the construction of the test reactor, and conversion conditions.

Candu Reactor

We will evaluate and study the appropriateness of this reactor for Japan on the basis of the latest knowledge, including economics.

Moving Forward with FBR Development

FBR Development Objectives and Development System

Because a considerable development period is necessary until the commercial use of a FBR, we will steadily continue the post-test reactor phase that continues from Monju, the prototype reactor, and work to develop FBR technology that can compete economically with the light water reactor.

Consequently, we are moving ahead with the following objectives looking to the commercialization of FBR.

1. Setting the launching of operations of the first test reactor (800,000-1,000,000 kW class) for 2030 and the construction costs at 1.5 times that of the light water reactor.

2. With regard to the development of FBR up to comemrcialization after the test reactor stage (an initial commercial reactor of 1.2-1.5 million KW), we will make the construction costs of an FBR at the commercialization stage equivalent to that of a light water reactor, and will build two initial early commercial reactors to achieve this by a phased approach. (Refer to Table 3)

The construction and operation of FBR after the test reactor will move forward mainly from the private sector, which will be centered around the electric power industry with appropriate assistance from the government.

The construction and operation of the test reactor will be carried out by the Japan Atomic Power Corporation.

Tasks in Terms of FBR Development

1. We will be putting together soon our basic thinking on the safety design necessary to choose the basic specifications of the test reactor. Furthermore, we will make improvements in rational safety design guidelines in order to maintain safety while at the same time improving the reactor's economics.

2. We will draft a comprehensive program to achieve the reduction of construction costs and implement it in a programmed fashion, and in this way, develop technology to improve the economics of the reactor.

3. In order to shorten the development period and reduce the development capital and risk, we will study the best ways to achieve concrete international cooperation.

4. In order to establish the processing of MOX fuel and the reprocessing of spent fuel for the FBR, we will move steadily forward with the development of technology in line with forecasts for the commercialization of the FBR.

Moving Ahead Steadily with Becoming a State Enterprise

Third Nuclear Fuel Cycle Reprocessing State to be Operational in 2010

If we view Japan's nuclear fuel cycle from 1955 to 2030, we can divide it into the following stages: 1. Research and Development Stage (1955-1985); 2. Establishment and Settlement Era (1986-2010); and 3. Growth Stage (2011-2030).

Long-term Uranium Forecast

1. World Uranium Underground Deposits and Supply and Demand

It is estimated that the future accumulated uranium demand of the free world over the 40-year period up to 2025 will be in the vicinity of 2-5.5 million tons of uranium.

In contrast, it is projected that around 15 million tons of uranium could be extracted in the free world at a price of under $130 per kilogram of uranium.

With the incentives to mine uranium on the decline, the amount of confirmed mine deposits has not increased in recent years, but if we increase the mining incentives to meet supply and demand conditions, we feel that the confirmed amount of underground deposits will increase.

Therefore, we can say at least that the amount of underground deposits will exist in 2030 that are necessary to fulfill the amount of accumulated uranium demand.

Japan's Supply Forecast

Japan's electric power utilities have been assuring about 195,000 short tons of U_3O_8 natural uranium by long-term contracts. It is forecast that this will supply Japan's needs up to the latter half of the 1990's.

However, we anticipate that the demand trend of countries overseas will cause worldwide demand to tighten in the 1990's.

Consequently, new procurement will be needed in the latter half of the 1990's, and over the long term, we will aim to increase the percentage of that amount imported, which now is 20 percent.

Moreover, we expect that our country's firms will grow to the point where they can conduct mining, development, production, and marketing on an international scale.

Enriched Uranium

It is forecast that we will be able to fully maintain our country's enriched uranium service demand until 2000 by consignment to the United States and France and the existing domestic enriched uranium program.

Because domestic enriched uranium is proceeding in an orderly fashion, we expect to supply ourselves in 2015 with 6,000 tons SWU per year of enriched uranium with domestic enriched uranium out of a domestic demand of 12,000 tons SWU per year.

Subsequently, while taking into account the commercialization and introduction of FBR, we will increase the percentage of domestic enriched uranium in an orderly fashion.

With regard to the laser method, which we believe has merit in terms of improving the economics, we will accelerate the development of tehcnology through public and private cooperation by making use of the research association method.

Reprocessing

We will treat the domestic reprocessing of spent nucler fuel as fundamental from the standpoint of being able to move ahead in a more concentrated and stable fashion with the peaceful use of nuclear energy and from the standpoint of being able to shift smoothly to the FBR era. Consequently, we are working towards the establishment of domestic technology in the first private reprocessing plant, and subsequently will endeavor to accumulate and develop technology.

We are considering a second private reprocessing plant from the standpoint of maintaining and improving reprocessing, the demand for plutonium, and the economics, and will make our decision based on that. In this case, our aim is for the plant to be operational around 2010.

MOX Processing

We expect that mixed oxygen (MOX) fuel processing will be carried out, as a matter of principle, by a domestic private enterprise after full-fledged use begins.

FBR Reprocessing

We will build a commercial FBR reprocessing facility when the commercial FBR era begins.

Waste Disposal

We expect to be able to handle low-level waste in general until about 2030 by means of the Rokkashomura storage facility in Aomori Prefecture, which is being prepared by the Japanese nuclear fuel industry.

With regard to high-level waste, we aim to test the disposal technology by 2000 with the government and private industry working together to realize that goal.

Moreover, to implement disposal smoothly, we are studying the implementation itself and the maintaining of costs. When deciding on the concrete implementation itself, we feel it is conceivable that the private sector will be the main force behind implementation.

Making a Positive Contribution to the World

Internationalization: Towards the Leading Role in Peaceful Uses

The development of the use of nuclear energy in Japan started about 10 years behind Europe.

However, although our country's nuclear energy technology grew to a level currently equal to that of the other nuclear energy advanced countries because of the efforts by both the public and private sectors, the perception of being "backward" remains.

Japan needs to switch from the past "catch-up" perception to a future perception of moving forward positively in worldwide nuclear development.

Japan is not only one of the "top 10 percent" of countries in the world in terms of GNP but is also in the amount of nuclear energy generated, and demands are intensifying for us to fulfill our international obligations.

Basic Thinking

When we look at the issue from an international standpoint, the United States is in a situation where it does not have as positive an attitude as in the past, and Japan and West Germany play the role of leader in the positive development of nuclear power technology.

Our nuclear power industry accurately grasps the development situation of nuclear energy which is becoming diversified, and is working towards self-development of uranium mining, the import and export of nuclear energy equipment, and international ties, such as technology cooperation.

Future means of Internationalization

World Opinion Leader

We will participate positively in discussions, centering around the IAEA, for the purpose of improvement of the international structure, such as the emergency notification system, which takes into account the circumstances following the recent Soviet accident.

1. Japan, as a major user of nuclear energy, has decided to sign and ratify the Nuclear Material Protection Treaty and will devise the measures required to establish international trust regarding peaceful uses.

2. With regard to safety measures of the IAEA, to which we gave a passive response to in the past, we now are, on the contrary, advocating that the best means for international protective measures be adopted from the standpoint that we will respond subjectively and will move ahead with international peaceful uses.

International Center for Peaceful Uses

1. Japan is at the world's highest level in advanced technology such as the operational administrative technology of nuclear plants. In the future, we will play the role of an "International Center for Peaceful Uses."

2. Along with spreading internationally Japan's excellent operational administration technology, we are studying the creation of the "Nuclear Silver Volunteer" system to make use of the abilities of middle-aged and older technicians.

Moving Ahead with International Joint Technology Development

We are pushing ahead positively with international joint technological development from the standpoint of making technology development more efficient, allocating the risks and costs, and contributing to the world.

Moving Ahead with Cooperation with the Developing Countries

1. Taking into account the increase in the desire of developing countries to develop nuclear power, we will carry out technical cooperation that stresses the safety areas with due consideration for nuclear non-proliferation.

2. We will deal appropriately with the developmental stage and needs of partner countries, and carry out information exchanges, feasibility studies, the fostering of human talents, technology guidance, electric generation plant equipment, and the supply of nuclear fuel cycle services. Moreover, we are moving ahead with a two-way regional cooperative system.

Making Positive Use of Private Sector Abilities

Nuclear Energy Industry: Conservative Service Sector Increases

Technology Development

It is expected that the private sector will take the lead in carrying out the technological development of nuclear energy which has grown into an "energy industry."

Under this circumstance, we are carrying out a review based on the following ideas with regard to the roles to be played by industry (the private sector), government (the public sector), and academe (the universities) in the technological development of nuclear energy as an "ordinary industry."

1. Development of the technology necessary for the nation to accomplish its objectives by itself, such as safety regulations and security measures.

We have been seeking to further the development of these technologies by taking on responsibilities in the government sphere, and, in the future, the government will move steadily ahead with technological development.

Other Technological Development

It is appropriate, in principle, for the private sector to be the main force behind technological development from the viewpoint that it is most effective for the parties actually using the technology to carry out its development.

Role of the University

It is hoped that the universities will carry out theoretical and basic research more positively from the viewpoint of further creative technological development which can create a wide variety of "seeds" [ideas] along with creating an educational environment of wide diversity and fostering researchers and technicians full of creativity and ideas.

Nuclear Energy Industry

In the nuclear energy industry market of 2030, the construction of plant facilities will continue its level trend, but the nuclear fuel cycle and administration and maintenance of plants will grow.

The overall market in 1985 was 1.6 trillion yen, and will reach 6.7 trillion yen in 2030. The accumulated cost over the 45-year period for plant construction will be about 50 trillion yen (less than one trillion yen for internally abandoned reactors), the administration and maintenance costs will be about 60 trillion yen, and the nuclear fuel cycle will cost about 70 trillion yen, for a total of 180 trillion yen. The proportionate weight of administration and maintenance and the fuel cycle is high. Therefore, an industry response is needed.

Maintaining and Raising the Activities of the Nuclear Energy Industry

1. Settled Stage (light water reactors, fuel processing, etc.)

We will take use of private sector abilities as the base, and the government will make the necessary adjustments to the environment.

2. Growth Stage (A large portion of the nuclear fuel cycle and new type reactors)

From the standpoint of energy security, we will improve the rate of self-sufficiency by the establishment of a domestic enterprise while working to improve the economics.

The government will switch its method of private sector assistance to an indirect method of using enterprises from a direct assistance method.

3. The Infancy Period (Nuclear fusion, etc.)

The government will move ahead in a planned fashion while keeping an eye on the effectiveness of its technological development.

Promotion of International Cooperation

To further comprehensive international cooperation in the nuclear energy field, we will hold discussions that will allow fuel cycle services to be supplied.

Guarantee of Talented Personnel

In response to the future increase of nuclear energy facilities, it is forecast that the number of operators and maintenance workers will increase from the present 40,000 men to 130,000 in 2030.

Consequently, we will work in the future to give complete education and training to the operators and maintenance personnel along with working to improve the mobility of personnel and personnel exchanges.

Site Policy

The size of nuclear energy facilities will increase to 137 million kW in 2030, and the number of necessary site locations is expected to increase by 35.

In this regard, if we consider the possibility of new facilities, we can think of the possibility of traditional site methods, but to carry out a site location policy that will increase the abundance of possible site locations and will be based on long-term forecasts, we will investigate and discuss new location methods along with furthering an increase in the number of reactors and the installation of large units.

Moreover, in order to advance the understanding of the people, we will push ahead with "the movement to spread nuclear energy terminology that is easy to understand," and will amend laws as needed.

Furthermore, in order to take advantage of locations where nuclear facilities are established as a means to promote the long-term prosperity of the region, it is important to make planned efforts based on concrete concepts and real scenarios that give life to the special nature of the region so that the facility and its effects are skilfully absorbed by the region and can be tied into the region's future development. The government will positively assist local self-help efforts in this regard.

Table 1 Future Forecast of the Size of Nuclear Energy-Generated Power

表1 原子力発電規模の将来予測

	(1) 事 項	(2) (実績)	(3)	(4) ケース 1		(5) ケース 2	
		1985年	2000年	2010年	2030年	2010年	2030年
6	総電力需要(億kWh)	5,928	8,990	11,300	15,900	10,100	12,400
7	電気事業用全発電設備(万kW)	15,425	23,200	26,900	34,300	24,400	26,700
8	原子力発電設備(万kW)	2,452	6,200	8,700	13,700	7,700	10,700
9	原子力発電設備構成比(%)	16	27	32	40	32	40
10	原子力発電電力量(億kWh)	1,590	3,700	5,500	9,000	4,800	7,000
11	原子力発電電力量構成比(%)	26	39	49	58	49	58

Key:

1. Item
2. (Actual Record) 1985
3. 2000
4. Case 1: 2010, 2030
5. Case 2: 2010, 2030
6. Comprehensive electricity demand (100 million kWh)
7. Total electric power facilities used by electric utilities (10,000 kW)
8. Nuclear energy-generated electric power facilities (10,000 kW0
9. Percent in overall total of nuclear energy-generated electric power facilities (%)
10. Amount of nuclear energy-generated electric power (100 million kWh)
11. Percentage of nuclear energy-generated electric power (%)

Table 2 The Scope of Development of the Nuclear Power Plants Necessary in the Future

表2 今後必要となる原子力発電所の開発規模

		1986年～2010年	2011年～2030年	1986年～2030年
1	ケース 1	6,300万kW (58) [100万kW (1)]	8,300万kW (64) [3,300万kW (25)]	14,600万kW (122) [3,400万kW (26)]
2	ケース 2	5,300万kW (49) [100万kW (1)]	6,300万kW (48) [3,300万kW (25)]	11,600万kW (97) [3,400万kW (26)]

3 (注) 1. ( ) 内は基数
2. [ ] 内はリプレース対応分で内数

Key:

1. Case 1 [Unit: 10,000 kW]
2. Case 2 [Unit: 10,000 kW]
3. Notes: 1. The number within the parentheses indicates the number of plants. 2. The number within the brackets indicates the number corresponding to replacements.

Figure 1 Size of Light Water Reactor Facilities

Key:
1. Unit: 10,000 kW
2. Next generation light water reactors
3. New Type light water reactors
3. (Plutonium Thermal Use)
5. Existing type light water reactors
6. Year

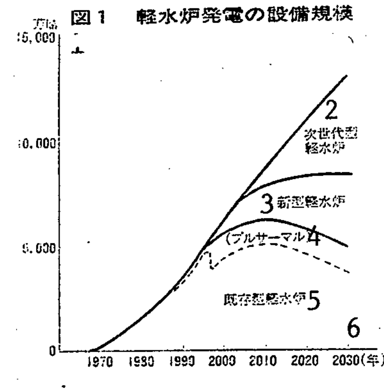
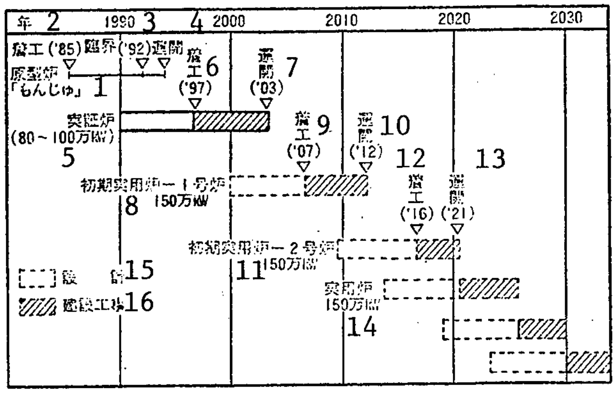


Table 3 FBR Development Objectives

		1 出力規模	運開時期 2	建設費の目標（軽水炉に対する倍率）3
4	実証炉	80～100万kWクラス	2003年頃	1.5倍程度
5	初期実用炉1号炉	130～150万kWクラス	2010年代前半	1.2倍程度
6	初期実用炉2号炉	130～150万kWクラス	2020年代前半	1.1倍程度

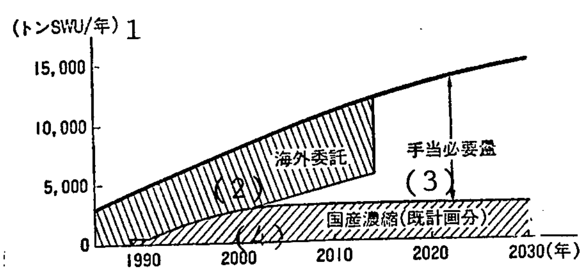
Key:
1. Output size
2. Start of operations
3. Construction cost objective (times the cost of a light water reactor)
4. Test reactor; 800,000-1,000,000 kW class; about 2003; about 1.5 times
5. First commercial reactor; 1.3-1.5 million kW class; first half of the 2010s; about 1.2 times
6. Second commercial reactor: 1.3-1.5 million kW class; first half of the 2020s; about 1.1 times

Figure 2 FBR Development Forecast



Key:

1. Prototype reactor, "Monju"
2. Breaking ground '85
3. Critical '92
4. Operational
5. Test reactor (800,000-1,000,000KW)
6. Breaking ground '97
7. Operational '03
8. First commercial reactor 1.6 million KW
9. Breaking ground '07
10. Operational '12
11. Second commercial reactor 1.5 million KW
12. Breaking ground '16
13. Operational '21
14. Commercial reactor 1.5 million KW
15. Design
16. Construction



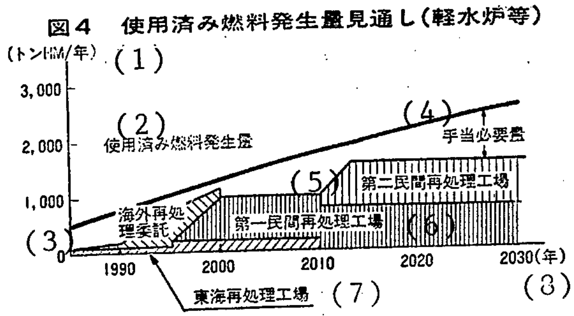
(5)

Figure 3 Enriched Uranium Service Forecast

Key:

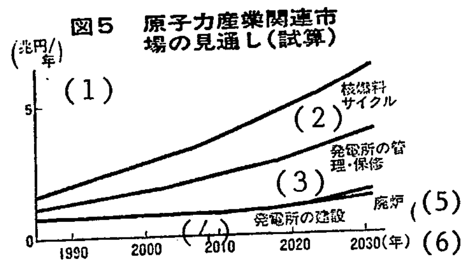
1. Tons SWU/year
2. Consigned overseas
3. Amount requiring treatment
4. Enriched uranium produced in Japan (already planned portion)
5. Year

Figure 4 Spent Nuclear Fuel Generation Forecast (Light Water Reactor, etc.)



Key:
1. Tons HM/year
2. Amount of spent nuclear fuel generated
3. Overseas reprocessing consignment
4. Amount needing treatment
5. Second private reprocessing plant
6. First private reprocessing plant
7. Tokai reprocessing plant
8. Year

Figure 5 Forecast of Nuclear Energy Industry Related Markets (Estimate)



Key:
1. One trillion yen/year
2. Nuclear fuel cycle
3. Administration and maintenance of power plants
4. Construction of power plants
5. Abandoned reactors
6. Year

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CHANGES IN SYSTEM FOR SELLING GOVERNMENT-OWNED PATENTS DISCUSSED

Tokyo JITA JAPAN INDUSTRIAL TECHNOLOGY ASSOCIATION in Japanese Aug 86 pp 4-6

[Article prepared by the Performance and Policy Group, General Affairs Section, General Affairs Department of the Agency of Industrial Science and Technology]

1. Introduction

The Budget Settlement and Accounting Regulations were revised last October, allowing the government to sell some patents and utility model rights to a private party to whom the government consigned research and development. The rights being sold are the results of such research and development.

Accordingly, the Patent Office formulated a Sales Contract for Government-Owned Patent Rights, which will serve as a standard form for such sales, and distributed it to various government agencies in February of this year. This article outlines the background, history, and content of this new [patent] sales system.

2. Background and History of the Establishment of This System

In the past, all patent rights resulting from research and development consigned by the government belonged to the government. The firm that carried out such a consignment was usually given only licenses to use them.

On this issue, private firms have advocated an adoption of measures to provide incentives to them with regard to the ownership of the patent rights and licenses to use them, in order to maximize the research and development capabilities of the private sector and contribute to the promotion of cross-licensing with foreign firms. (See "Views on the Promotion of Technology Innovation" by the Engineering Club of the Federation of Economic Organizations," dated 25 November 1980; and "Suggestions for Science and Technology Policies," by the Federation of Economic Organizations, dated 12 January 1982.)

Also, the Temporary Administrative Study Council issued its Third Report (Basic Report) on 30 July 1982, stating that "the handling of patent and other rights related to consigned research must be examined and improved quickly to provide the consignees with incentives." Moreover, the Council for Science

and Technology issued its Report No 11 on 27 November 1982, which pointed out that "in defining rights on research results or licenses to use them, it is necessary to examine the possibility of granting parts of patent rights or priority licenses for using such rights to those who cooperated."

On 27 November 1984, MITI [Ministry of International Trade and Industry] also pointed out at a joint meeting of the Planning Subcommittees of the Industrial Structure Council and the Industrial Technology Council that "it is necessary to take measures that will allow the government to share patent rights derived from consigned research with the consignees, or grant them licenses for using such patents at nominal or no cost by introducing exceptions in financial laws."

In view of these events, when the Fundamental Technology Research Harmonization Act was enacted last year in cooperation with the financial authorities [of the government], MITI examined the establishment of exceptions to the Finance Law so that there could be joint ownership with consignees of patent rights resulting from consigned research and development. As a result, MITI concluded that: 1) a consignment is equivalent to commissioning in civil law, thus the results of such a consignment should belong to those who consigned the task, and 2) hence, if all or part of the patent rights that resulted from consigned research and development are granted to the consignee, then consignment fees become "financial grants without corresponding return," as specified in the Grant Rationalization Act. (Footnote 1) (Laws to rationalize the execution of grant related budgets.) Thus, the fees become grants, and it is impossible to allow for exceptions to the Finance Law within the framework of the current consignment system. If it is necessary to let a consignee own patent rights that once belonged to the government, then the ownership must be obtained through a government transfer of these rights (for a fee) to the consignee.

Based on this conclusion, MITI wishes to activate consigned research and development by encouraging willingness to carry out research on the part of consignees and to invigorate joint international research and development activities through cross-licensing between consignees and foreign firms. To achieve these goals, MITI has realized that it must share patent rights that resulted from consigned research and development by transferring parts of such rights to the consignees.

3. Partial Amendment of Budget Settlement and Accounting Regulations

As a result of continued consultation with the financial authorities about sharing patent rights, Article 99 of the Budget Settlement and Accounting Regulations (to be referred to as the Budget Accounting Regulations hereafter) was amended as of 4 October of last year. Article 99 of the Budget Accounting Regulations specifies cases in which negotiated contracts are permitted in selling or buying which involves the government. Since a negotiated contract is required to transfer (= sell) government-owned patent rights only to a consignee, Article 99 was amended to include a clause on selling patent rights to a consignee.

Notable features of the amendment are listed below.

(1) Testing and research has been commissioned by the "government." For instance, tasks consigned by the Agency of Industrial Science and Technology qualify, but tasks consigned by the New Energy Development Organization (NEDO) using grants it obtained from the government do not.

(2) Only "a portion of patent and utility model rights" can be sold. Hence, items under examination that have not been registered as rights do not qualify. Also, patent or utility model rights cannot be sold in their entirety. As a result, these rights will not be owned solely by a consignee but will be shared by the consignee and the government.

(3) Rights can be sold only to "those who were commissioned for the tests and research in question." Therefore, when a task is consigned to a research cooperative, derived rights can be sold only to the cooperative. However, as is described later, there is no practical problem because resale is allowed when required.

4. Sales Contract for Government-Owned Patent Rights

Following this partial amendment of the Budget Accounting Regulations, it was necessary to unify the handling of [patent right] sales contracts by various government agencies. Therefore, the Patent Office consulted with the Ministry of Finance and the Agency of Industrial Science and Technology, coordinated with patent officers from various ministries and agencies, and formulated a sales contract for government-owned patent rights. This contract format was transmitted to relevant agencies through a memorandum from the Patent Office director dated 26 February of this year. Due to limited space, detailed explanations of this contract will be deferred to another occasion. Only a few items that may require explanation are listed below.

(1) Object of contract

As the contract's title indicates, it is concerned mainly with patent rights. For utility model rights, however, the same contract format can be used simply by replacing the words "patent rights" with "utility model rights."

(2) Concerning Article 2

On patent rights to be sold, the Budget Accounting Regulations state "...a portion of patent and utility model rights" but does not specify what the word "portion" means. In this contract, sales of patent rights are limited to less than 50 percent of the said rights, in view of public benefits that may be derived from specific patent rights.

(3) Concerning Article 3

There are two ways to determine the compensation (price) for selling patent rights: The principle of cost or the principle of profit. When applied to commissioned research, the principle of cost is the approach in which the

price is that portion of the commission fees that were needed to generate the patent rights in question. This system is used in the sales of patent rights by NEDO (Footnote 2) (Patent rights from the results of research consigned by NEDO to private firms belong to NEDO. A system exists to share these rights by transferring them (for a fee) to consignees, but it has never been used.), but the price under such a system tends to be too high, making the system impractical.

In contrast, a price based on profit will include the total amount of profit generated by owning the patent rights being sold. In reality, the price is taken to be the total amount of estimated license fees for using a patented invention from the sales date to the end of the licensing period. This comes from the idea that license fees are based on the profit derived from using a patented invention. This pricing method is considered to be fair because the same method is used in determining license fees for government-owned patent rights. (Footnote 3) (Contract to license government-owned patent rights (Patent Office director's memorandum "Tokuso" No 58, dated 27 February 1950).)

If the patented invention is already licensed, future license fees will be determined by fees already paid, otherwise fees will be determined according to the fees charged for similar patented inventions already licensed.

(4) Concerning Article 9

As was stated above, only a portion of the patent rights are sold to a consignee, and the remainder (held by the government) is still owned by the government and remains government-owned patent rights. Hence, when such patent rights are exercised by a consignee, he must pay the appropriate compensation, that is, appropriate license fees corresponding to the rights still owned by the government, according to the regulations of the Government Property Act and Public Accounting Act.

This article corresponds to Clause 2, Article 73 of the Patent Act that defines "a case stipulated by a separate contract."

(5) Concerning Article 10

When one of the joint owners of a patent right wishes to grant licenses to a third party, he must obtain the consent of the other owners (Clause 3, Article 73 of the Patent Act). It is necessary for the government, however, to assure the possibility of granting licenses to a third party without the consent of other owners in special circumstances to protect the public's welfare. The intent of this article is to obtain blanket consent from a consignee beforehand, but with the consent being limited to special circumstances.

However, the expressions used in examples cited in the supplementary explanations of these special circumstances are quite limiting, and very careful handling is expected in enforcing this article in actual cases.

(6) Concerning resales

When a consignee wants to resell its share [of patent rights] to a third party, the consent of the government--which is a co-owner of the rights--is needed according to the Patent Act's requirements. Since the intent of the amendment to the Budget Accounting Regulations was to activate consigned research by encouraging willingness to carry out such research, consent for resale should be controlled. For instance, consent should be limited to such cases as a research cooperative reselling patented inventions to a firm affiliated with the research cooperative and to which the researcher(s) who actually performed the invention belongs.

5. Conclusion

This is a system which, for the first time, opens the possibility of sharing patent and utility model rights, which resulted from research and development consigned by the government and remained totally owned by the government so far, with consignees. This system is likely to provide a maximum incentive to consignees within the framework of the current consignment system. More vigorous activity in commissioned research and development is expected from initiating this system.

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END